White Rabbit Management and Monitoring

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Agenda

- A few words about myself
- Short overview of White Rabbit network and equipment
- Supported protocols for monitoring and management
- Command line tools
Who am I?

(In the context of White Rabbit Management and Monitoring)

- Worked at CERN for 5 years (2014-2019)
  During this time:
  - Maintainer of White Rabbit Switch software
    - Over 900 commits
    - Integrated SNMP, LLDP, Kerberos+LDAP daemons
    - Implemented WR-SWITCH-MIB
  - Key developer of WRPC software (WR node)
    - Over 500 commits
    - Developed SNMP agent
    - Developed LLDP daemon
  - Involved in the design of configuration tool for WRS at CERN
  - Supported integration of WRS and WRPC monitoring at CERN
  - Implemented White Rabbit dissector for Wireshark sniffer
- Since 2020:
  Independent White Rabbit and Embedded Systems consultant:
  - Implemented BRIDGE-MIB and Q-BRIDGE-MIB for WRS
  - Implemented VLAN support for LLDP
  - Author of MIB for IEEE 1588 (PTP) standard
Agenda

- A few words about myself
- **Short overview of White Rabbit network and equipment**
- Supported protocols for monitoring and management
- Command line tools
Transmission medium

- e.g. coaxial cable

Using White Rabbit

WR network
Example White Rabbit network

- Challenging to manage big network
White Rabbit Switch (WRS)

- 18x 1GbE ports (SFP)
  - Supports 1Gb SFPs (fiber, copper (no WR))
  - WR supported only on some fiber SFPs
- 1x 100Mbit Management port (RJ-45)
- White Rabbit network is separated from management
  - It is possible to hack, but limited throughput (~1MBit/s)

More information about WR switch:
https://ohwr.org/project/white-rabbit/wikis/SummaryWRProjects#switch-related
Monitoring of White Rabbit network

Diagram showing the network topology with a Grand Master, Boundary Clocks, and various nodes connected to a monitoring station.
White Rabbit Node

- White Rabbit PTP Core (WRPC)
- Usually 1x 1GbE WR port
- In a host or standalone mode
- Management and Monitoring functions implemented in Soft Core CPU (LM32) in FPGA
- Very limited resources (esp. memory)
- In form of different standards:
  - PICe: SPEC
  - VME: SVEC, VFC-HD
  - CPCI: SPEXI
  - uTCA
WRPC: communication
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**White Rabbit**

**What is White Rabbit?**

- Initiated to renovate CERN’s and GSI’s accelerator timing systems
- **Based on well-established standards**
  - Ethernet (IEEE 802.3)
  - Bridged Local Area Network (IEEE 802.1Q)
  - Precision Time Protocol (IEEE 1588)
- **Extends standards** to meet new requirements and provides
  - Sub-ns synchronisation
  - Deterministic data transfer
- Initial specs: links ≤10 km & ≤2000 nodes
- **Open Source and commercially available**

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Source: https://ohwr.org/project/white-rabbit/wikis/uploads/da6d8abed6402112c5c1c007b4222919/wr_ws11_intro_2021_10.pdf

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**Let’s use it!**
Network monitoring (SNMP)

- Timing monitoring (Sync status)
- WRS: more than 300 specific parameters
- WRPC: ~70 parameters

Nagios

Service Status Details For Host ‘2.WRS.1’

LHAASO

Monitor: WRS sync status, packet flow of WRS port, RTT, temperature, etc..

Source: https://ohwr.org/project/white-rabbit/wikis/uploads/ea8d1e8ac37a97d1f03cb097d081b8b4/WR_at_LHAASO.pdf
Monitoring example

- Is the correction by White Rabbit needed?
- Link ~5km, underground
- ~400ps RTT difference between day and night
- >1ns due to the weather

![Ptp Round-Trip-Time History](image)
WRS: SNMP

- WR-SWITCH-MIB (in wr-switch-software repo)
  - status OIDs
  - expert OIDs like:
    - Port status and configuration
    - Timing status and configuration
    - SFP monitoring (e.g. vendor, temperature)

More in “White Rabbit Switch: Failures and Diagnostics”

- Standard MIBs (to be included in the next firmware release):
  - MIB-IP
  - Q-BRIDGE-MIB (VLANs)
  - BRIDGE-MIB (MAC routing tables)
  - Ongoing standardization of MIB for PTP
    - Implementation in the future

- Note: SNMP cannot be used to change the configuration of WRS
WR Switch: Failures and Diagnostics

- Document published with WR Switch firmware release
- Lists various errors reported by a switch
- Analyses problems that cause the error
- Proposes actions to mitigate problems
- Similar document exists for WRPC (node)
WRPC: SNMP

- WR-WRPC-MIB (in wrpc-sw repo)
  - No status OIDs
  - Port’s statistics
  - PTP/WR timing status and configuration
  - SFP calibration database
  - SFP monitoring (temperature, RX/TX power)
- SNMP can be used to configure some parameters:
  - SFP database
  - Init script
  - Remote shell command execution
- Not Secure! No SNMP v3
Network Topology (LLDP)

- What device is on the other side of a link?
- Supported by WR Switch and WRPC

Source: https://lldpd.github.io/media/images/why.png
Network Topology (LLDP)

Real life example: GSI

Source: https://ohwr.org/project/white-rabbit/wiki/uploads/a9d91abf3b93a50065154943f8f82747/2021_wrgsi_wrWorkshop_v1.pdf
**WRS: RADIUS**

- Based on information on RADIUS server, WRS can limit access to WR network.
- Uses VLANs to limit access.
- To be included in the next firmware release.
WRS: Configuration file

Applied at startup, contains:
• Management interface’s configuration
• Timing configuration (calibration values, mode)
• Remote log server address
• Log verbosity level
• VLANs configuration
• and more
WRS: Configuration file

• Kconfig format
  • The same as used by Linux Kernel
  • \{key\}={value} format

```plaintext
CONFIG_ETH0_DHCP=y
# CONFIG_ETH0_DHCP_ONCE is not set
# CONFIG_ETH0_STATIC is not set
CONFIG_HOSTNAME_DHCP=y
# CONFIG_HOSTNAME_STATIC is not set
[...]
CONFIG_REMOTE_SYSLOG_SERVER="be-co-tracing"
CONFIG_REMOTE_SYSLOG_UDP=y
CONFIG_WRS_LOG_HAL="daemon.info"
CONFIG_WRS_LOG_LEVEL_HAL="0"
[...]
# Port Timing Configuration
#
CONFIG_PORT01_PARAMS="name=wri1,proto=raw,tx=223897,rx=226273,role=master,fiber=0"
CONFIG_PORT02_PARAMS="name=wri2,proto=raw,tx=224037,rx=226377,role=master,fiber=0"
CONFIG_PORT03_PARAMS="name=wri3,proto=raw,tx=224142,rx=226638,role=master,fiber=0"
CONFIG_PORT04_PARAMS="name=wri4,proto=raw,tx=224313,rx=226471,role=master,fiber=0"
```
WRS: Config file handling

- Local on a switch
- Retrieved from a network at boot (via TFTP, FTP or HTTP)
- Path to a config provided in a DHCP response
WRS: Editing config file

- In text editor
- Kconfig tools (make menuconfig, make nconfig etc.)
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- Web interface (not recommended!)
- Custom tool, CERN: Controls Configuration Data Editor (CCDE)

Step 1: Web interface for DB, it generates WR Switch config in JSON format
Step 2: Switch config is generated from JSON format by generator:
https://gitlab.cern.ch/white-rabbit/wrs-config-generator
WRS: Editing config file

- In text editor
- Kconfig tools (make menuconfig, make nconfig etc.)
- Web interface (not recommended!)
- Custom tool, CERN: Controls Configuration Data Editor (CCDE)
- Custom scripts to distribute config files (GSI)

Note: some features need to be enabled and configured in a config file to work
WRPC: Configuration

- Text file, syntax the same as WRS config
- Kconfig tools on host (make menuconfig, make nconfig etc.)
- Applied at **build time**
- For some features the configuration can be done by a shell command in run-time
- Startup script defined:
  - At build time
  - Run-time (saved in flash)

Note: To keep the footprint small many features are disabled by default.
WRS: other supported protocols

- VLANs (limit access between network parts)
- Syslog (logging)
- Kerberos and LDAP (authentication and authorization)
WRPC: other supported protocols

- VLANs (limit access between network parts)
- Syslog (logging), events like:
  - boot up
  - link down/up
  - sync lost
  - sync recovered
  - Temperature over threshold
- BOOTP
- Netconsole
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WRS: wr_mon

- The best CLI tool to start with
- Gives many important information about WR Switch status and configuration:
  - Build version (of the tool! Not of the entire firmware. For the deployed firmware should not matter)
  - Link status
  - PTP/WR configuration
  - MAC of the peer (*)
  - PLL locking status
  - Timing mode
  - WR time
  - Servo status (if in slave mode)
- Similar tool exists for WRPC (gui)

(*) - available in the next firmware release
WRS: More CLI tools

- More CLI tools available:
  - wrs_shmem_dump – display internal data structures of WR specific processes
  - rtu_stat – display switching tables
  - wrs_vlans – display vlans configuration
  - wr_pstats – detailed interface statistics
  - Number of files in /tmp – status of several subsystems
  - ptpdump, tcpdump & wireshark (with WR dissector) – PTP/WR frames analysis
  - wrs_dump.sh – remotely create dump of WRS state
- More details about these tools can be found in:
  - *WRS user manual*
  - presentation "A quick tour through the available diagnostic and monitoring tools for White Rabbit Networks"
    https://ohwr.org/project/white-rabbit/wikis/uploads/c5a4ca468edc2251874c3694867e12fc/tools_diagnostic_monitoring.pdf
WRPC: console

- Ways to access console
  - `vuart` on host via local bus (e.g. PCIe)
  - `serial console` via micro USB
  - `netconsole` via WR network
  - Remote command execution using SNMP via WR network

- One console instance (input/output is mirrored)
- No access control

Netconsole
SNMP

WRPC: console

- `wrc#`
- `serial console`
- `vuart`
- `WR network`
WRPC: more CLI tools

- Tools working over local bus:
  - wrpc-dump – interpret data structures in node’s memory
  - wrpc-diags – display node’s status (similar to gui command)

More details about these tools can be found in:
- White Rabbit PTP Core User’s Manual
- presentation “A quick tour through the available diagnostic and monitoring tools for White Rabbit Networks”,
  https://ohwr.org/project/white-rabbit/wikis/ uploads/c5a4ca468edc2251874c3694867e12fc/tools_diagnostic_monitoring.pdf
Thank you!
Questions?
Further reading